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ASYMMETRIC ANALYSIS IN OKUN'S LAW IN CASE OF PAKISTAN: A THRESHOLD COINTEGRATION ANALYSIS

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ABSTRACT

Time series data entails considering the linearity or nonlinearity along threshold level before processing it to comprise in a model for policy makers to policy implication. Enders and Siklos (2001) claimed that the Engle and Granger (1987) procedure would be misleading in case if time series possesses possible asymmetric relationship. They recommended a model which includes the asymmetric adjustment to get stationarity of error term. This adjustment process is established by Balke and Fomby (1997) to familiarize Threshold co-integration to combine nonlinearity and co-integration along threshold error correction model additionally Hansen and Soe (2002) also advanced to test for asymmetry. The plenty of past and existing foreign studies point out that Okun's coefficient is asymmetric in upswing and downswing phase of the economy because of labor force participation rate and sectorial growth rates. This study is to test the hypothesis of linear cointegration against threshold cointegration and asymmetric adjustment between unemployment rate and output for the time period 1964-2014. Further, the null hypothesis of linear cointegration is rejected against threshold cointegration. It is considered that the results of this study would assist the policy makers in formulating diverse policies related to macroeconomic targets like to stabilize prices, achieving targeted level of economic growth and to reduce the unemployment level and reduce the forecasting error of unemployment rate and output.

Keywords: Output, Unemployment Rate, Threshold Cointegration

INTRODUCTION

Asymmetry, states a relationship that is not one of direct proportion, has been extensively debated by statisticians, mathematicians and the economist as well (Engle and Granger, 1987 & Balke and Fomby, 1997). While the dawn of the notion of asymmetry is deeply mathematical in nature its implications and bearings are not constrained to the arena of mathematics alone. The hypothesis of the Okun's nonlinearity states that economic expansion is of lengthier period of regime as compared to the time period of the economic contraction but economic expansion is less sharp in nature than the economic contraction (Enders, 2010 & Balke and Fomby, 1997).

The relationship between unemployment and output empirically and theoretically was first discovered and tested by the Arthur Melvin Okun (1962) and known as the Okun's law; which reveals that 3% (increase/decrease) in economic growth would lead to 1% (decrease/increase) in unemployment; a negative variation between unemployment and economic growth. Theoretically Okun's law is the loop between the aggregate supply and Philips curve (Debelle and Laxton, 1997) and empirically it is "rule of thumb" for policy devising and forecasting (Harris and Silverstone, 2001). Okun's related 3 to 1% relationship in change in economic growth and unemployment, but further by testing more econometrically it reduces 2 to 1% (Samuelson and Nordhaus, 1995). The stability of Okun's law is of much contradiction (Knoester, 1986; Kaufman, 1988; Weber, 1995; & Moosa, 1997).

For policy makers, this relationship is of distinctive concern. Their main interest is to find how much percent growth of output is mandatory to condense unemployment rate by one percentage point? Further, the reaction of unemployment due to output fluctuation also helps to formulate the dis-inflation policy (Khalil, *et al.*, 2011). Unemployment is foundation of plenty of costs to unemployed people as well as their families, society and government too (Ahmed, *et al.,* 2011). The unemployment carries a transitivity stuff like when the idle labors cut short their spending, it would result to diminish the demand for output growth and which further become reasons for the unemployment of others labors (Bardsen, *et al.,* 2011).

Time series data requires to considering the linearity or nonlinearity, along with threshold level, if any, before processing it to include in any model and further policy recommendations. The nonlinear behavior of the economic time-series has been acknowledged mainly after the post-war period when key economic time series of U.S. and Europe unveiled asymmetry. Conversely, its presence has been recognized long before the war. Pre-war testimonials of Keynes (1936) noticeably designate that the business cycles are nonlinear. Hicks (1950) and Neftci (1984) advocated that business phases are nonlinear, in that the magnitude of the feedback of a GDP's rate of change to hitherto recorded shock depends upon the sign of those shocks. The number of studies in the last decade, showed the evidence of asymmetries in Okun's relationship. Asymmetry in Okun's law is caused by a discrepancy between unemployed and jobs interims of sector and regions, to a great extent in contraction phase of the economy (Mayes and Viren, 2002). Unemployment exhibits a nonlinear behavior due to diverse phases of the business cycles as (Skalin and Terasvirta, 2000; & Cancelo, 2007).

There are at least four explanations for which it is to be considered for testing nonlinearity in Okun's law. Firstly, it most probably backings in discriminating among substitute theories of joint goods market behavior and labor market. Secondly, if Okun's relationship is found to be nonlinear then it would definitely strengthen the nonlinearity too in Phillips curve. Thirdly, in case of structural policies (for example, labor market reforms) and stabilization policies (for example, appropriate monetary policy responses) as well the knowledge of the extent of nonlinearity in Okun's law is necessary. Fourthly, it would definitely lead to forecasting errors in case of ignoring asymmetry in Okun's law, when it is present (Harris, *et al.*, 2001; Palley, 1993; & Rothman, 1988).

Developing countries, like Pakistan, face many macroeconomic challenges like to achieve reasonable economic growth and the employment level. For this purpose following questions are found to be relevant to research as: Does there occur linear or nonlinear cointegration between unemployment and output? Whether there is found linear long run adjustment or threshold long run adjustment between unemployment and output? These are the questions which should be addressed properly for policy makers as well as to avoid the forecasting error.

The concept of cointegration is first introduced by Granger (1983) and Granger and Weiss (1983) for two variables. Further, this work extended by the Johensen (1991) for more than two variables; when there are multi-cointegrating variables. However in literature a lot of the debates have been done on the adjustment coefficient of ECM. In the traditional approach of Engle and Granger (1982) and Johenson and Juselious (1990) the underlying assumption is that disequilibrium advances toward a long-run equilibrium and this adjustment prevails in every time period. On contrary to this, Balke and Fomby (1997), Enders and Siklos (2001) and Hansen and Soe (2002) argued that such movements toward the long-run equilibrium don't compulsory to occur in every period. Implicit in a lot of the conversation of cointegration and its relevant ECM is the assumption that such a movements to advance toward a long-run equilibrium prevails in every time period. However, it is potential that such movement toward the long-run equilibrium not compulsory to occur in every period.

For instance, economic agent would not adjust continuously due to the presence of fixed costs of adjustment. Solely once the deviation exceed by a particular threshold away from the equilibrium, now the advantage of adjustment exceed the costs, and hence, the economic agents act to maneuver the system towards back the equilibrium. This sort of idiosyncratic adjustment process has been used to explain several economic phenomena together with the behavior of money balances, prices, consumer durables, inventories, and employment. Threshold cointegration provides the opportunity to characterize this separate or discrete adjustment.

More specifically, threshold cointegration is beneficial where the co-integrating relationship among variables is inactive within a specified interval and then becomes active once the system reaches too away from the 'equilibrium' that is, if the system cross a bound level of threshold, cointegration turns active. This adjustment process motivated Balke and Fomby (1997) and Enders and Siklos (2001) to introduce Threshold co-integration to combine nonlinearity and co-integration. They further extended the work where adjustment towards equilibrium don't occur after every small deviation but after a threshold point; until the deviation is not greater than transaction cost the adjustment will not take place. This evidence is further supported by many researchers (Obstfeld and Taylor, 1997, Michael, *et al*., 1997, O'Connell and Wei, 1997, O'Connell, 1998, Balke and Wohar, 1998, Baum and Karasulu, 1998, Enders and Falk, 1998, Martens, *et al*., 1998, Lo and Zivot, 2001, Baumet, *et al*., 2001 and Taylor, 2001).

The plenty of studies have been done which measure both difference and gap version of linear Okun's model Hsing (1991), Parachowny (1993), Freeman (2000), Sogner (2002), Christopoulos (2004), Knotek (2007), Boris Petkov (2008), Villaverde and Maza (2008), Mitchell and Pearce (2010) and gave different Okun's coefficient estimate depending upon different regimes and phases of the economy. In case of Pakistan, Hassan (2012), Khan, *et al*. (2013) and Wajid (2013) investigated linear Okun's law by means of traditional OLS method for both gap version and difference version and refused cointegration relationship and Okun's coefficient presence for Pakistan economy. Further over nonlinearity in Okun's law a bulk of empirical literature provided Courtney (1991), Palley (1993), Montgomery et al. (1998), Lee (2000), Mayes and Viren (2002) and Silvapulle, Moosa, and Silvapulle (2004) by means of threshold cointegration and asymmetric adjustment. To best of my knowledge, hardly any study has been done in case of Pakistan which incorporated nonlinearity in Okun's law.

Thus without considering the nonlinearities in case of Pakistan, researchers have done their job since the arrival of research by Balky and Fomby (1993) and Enders and Siklos (2001). Threshold cointegration has widely been adopted and it enabled the policy makers to device the policies considering the relationship between unemployment and economic growth on both sides of the threshold level. The aim of this paper is to test the asymmetry in Okun's law for gap model by means of both Enders and Siklos (2001) and Hansen and Soe (2002) method of threshold cointegration and threshold vector error correction model.

Further ahead of this study is arranged as follows that next section (II) methodology, section (III) presents data and variables in brief, (IV) provided the estimation and results and section (V) explains conclusions. At the end of the study there are some policy recommendation derived on this study.

THE OKUN'S MODEL AND THRESHOLD COINTEGRATION TESTS

The difference version approach of Okun's relationship is empirically shown as:

$$\Delta u_t = \gamma + \alpha \Delta y_t + \varepsilon_t \qquad (1)$$

In equation (1), $\Delta u_t = (U_t - U_{t-1})$, $\Delta y_t = (Y_t - Y_{t-1})$ and α/γ = Okun's coefficient/intercept.

U_t = Unemployment rate at period t. U_{t-1} = First lag of unemployment.

Y_t = Output of time period t.Y_{t-1} = First lag of output.

ε_t = error term of time period t $(iid(0, \sigma^2))$.

In this approach of Okun's law, output growth is regressed variations in unemployment rate, 'α' is denoted as Okun's coefficient (the rate of variation in output growth by dint of unemployment rate) and it should be expected to hold negative sign due to the negative relationship between unemployment rate and economic growth. While y_t and u_t are nonstationary, they should be cointegrated through vector $\beta' = [1, \ -1]$ to explain the equation (1) with more accurately and precisely. Only if the relationship between output and unemployment rate are stable, that is, asymmetric or symmetric cointegrated adjustment, the control and prediction of either Okun's coefficient or output are possible. Hence, test of cointegration is prerequisite by unspecified vector. In this study explicitly employs two test of threshold cointegration advanced by Enders and Siklos (2001) and Hansen and Soe (2002).

The assumption of Enders and Siklos (2001) test of cointegration for nonlinear adjustment as follows; let $\{y_{it}\}_1^T$ represent observable random variables that are integrated of order one (*I(1)*). The long-run stable or equilibrium relationship can be given as:

$$y_{1t} = \hat{\beta}_1 + \hat{\beta}_2 y_{2t} + \cdots + \hat{\beta}_n y_{nt} + \epsilon_t \quad (2)$$

Where $\hat{\beta}_i$ = estimated parameters and ϵ_t are residuals. The stationarity of residuals (ϵ_t) confirm the long-run equilibrium or stable relationship. The residual term is stationary if $-2 < \rho < 0$ given by:

$$\Delta\epsilon_t = \rho\epsilon_{t-1} + e_t \qquad (3)$$

Here, e_t is attributed as white-noise errors. The symmetric adjustment or symmetric stability holds for long-run equilibrium if $-2 < \rho < 0$ and the equation (3) is acknowledged. However, the framework of standard or traditional cointegration in (3) is misleading, in phenomenon, if there occur asymmetric adjustment process. That is the reason due to which Enders and Siklos (2001) suggested an asymmetric adjustment for such type of process that is called threshold autoregressive (TAR) adjustment model as follows:

$$\Delta\epsilon_t = I_t \rho_1 \epsilon_{t-1} + (1 - I_t)\rho_2 \epsilon_{t-1} + \varepsilon_t \quad (4)$$

Where $I_t\ (indicator\ function) = 1$ if $\epsilon_{t-1} \geq \tau$ (threshold level) else zero. If there is occurring serial correlation in (4) then it re-written as:

$$\Delta\epsilon_t = I_t \rho_1 \epsilon_{t-1} + (1 - I_t)\rho_2 \epsilon_{t-1} + \sum_{i=1}^{p} \gamma_i\ \Delta\epsilon_{t-i} + \varepsilon_t \qquad (5)$$

The method, to test threshold cointegration, is proposed by Enders and Siklos (2001) and is called the Φ. The F-statistics comprises procedure to test the null hypothesis $\rho_1 = \rho_2 = 0$ is used by the Φ. The τ (threshold parameter) is restricted to be within 70% range of ϵ_t, while from both ends 15% values are excluded of an ascending or descending series of ϵ_t for the purpose to attain minimum residuals sum of squares from (4) or (5)[1]. Through F-statistic the null hypothesis (liner cointegration) $\rho_1 = \rho_2$ is tested (it is therefore because there is a stationary system) against the alternative of threshold cointegration, if no cointegration hypothesis is rejected.

Additional test of nonlinear cointegration is advanced by Hansen and Soe (2002) reveals that within a certain range cointegration relationship does not persist, rather it persists if the system exceeds a specific threshold level. A new refinement in this literature is provided by

[1] Tests have been proposed by Enders and Siklos (2001) for both phenomenon's such as when τ (threshold parameter) is known else unknown, but here an unknown τ is applied as because lack of an a priori reason to accept that τ is known.

Hansen and Soe (2002), for examining the unidentified cointegrating vectors. Also, these authors proposed a vector error correction model (VECM) by one cointegrating vector along a threshold upshot based in *VECM* and established a test of lag-range multiplier (LM) meant for threshold presence effect in VECM. This test contemplates a two regime threshold cointegration model, or a nonlinear VECM of order *l+1*, as follows:

$$\Delta x_t = \begin{bmatrix} A_1' \ X_{t-1}(\beta) + u_t & if \ w_{t-1}(\beta) \leq \gamma \\ A_1' \ X_{t-1}(\beta) + u_t & if \ w_{t-1}(\beta) > \gamma \end{bmatrix} \quad (6)$$

along

$$X_{t-1}(\beta) = \begin{Bmatrix} 1 \\ w_{t-1}(\beta) \\ \Delta x_{t-1} \\ \Delta x_{t-2} \\ \vdots \\ \Delta x_{t-l} \end{Bmatrix}$$

Where x_t is a p-dimensional *I(1)* time series that is cointegrated by one $\rho \times 1$ cointegrating vector β, $w_{t-1}(\beta) = \beta' x_t$ is the *I(0)* ECM term, u_t is an error term, A_1 *and* A_2 are coefficient matrices which describe the dynamics in every of the regimes, and γ is the threshold parameter.

As it can be seen, the threshold model (6) has two regimes, defined by the value of the error correction term. As long as deviations by the equilibrium are lesser or equal than the threshold, there is no tendency for the variables x_t to revert to an equilibrium (i.e., the variables would not be cointegrated); quite the reverse, if deviations by the equilibrium are larger from the threshold, there is a tendency for the variables x_t to transfer towards some equilibrium (i.e. the variables would be cointegrated).

Moreover, Hansen and Soe (2002) put forward two consistent-heteroskedastic statistics *of LM* test for the null hypothesis of linear cointegration (i.e., model (6)). The first test would be applicable when true cointegrated vector is known as a priori, and is denoted as:

$$\sup LM^0 = \sup_{\gamma_L \leq \gamma \leq \gamma_U} LM(\beta_0, \gamma) \quad (7)$$

Where β_0 is fixed (i.e., $\beta_0 = 1$) whereas the second test apply able when true cointegrating vector is unidentified, and is denoted as:

$$\sup LM = \sup_{\gamma_L \leq \gamma \leq \gamma_U} LM(\hat{\beta}, \gamma) \quad (8)$$

Where $\hat{\beta}$ is the null estimate of β. In both tests, $[\gamma_L, \gamma_U]$ is the search region set so that γ_L is the π_o percentile of $\widetilde{w}_{t-1}$, and γ_U is the $(1 - \pi_o)$ percentile; Andrews (1993) suggests setting π_o between 0.05 and 0.15. Finally, two bootstrap methods to calculate asymptotic critical values and *p-values* are provided by Hansen and Soe (2002).

THE DATA AND VARIABLES

In this section, the discussion revolves around defining and describing the variables that are used for estimation of threshold cointegration and asymmetric adjustment in Okun's law. These are unemployment rate and output level. The gross domestic product (GDP) has been taken as measure of output. It is measured at constant local currency unit, therefore, it represents real GDP. The unemployment rate is defined by Ministry of Finance Government of Pakistan as, the percentage of the presently active population said as the unemployed population which is unemployment rate. The currently active population comprises all individuals ten years or more than this age who accomplish the necessities for containing among employed and unemployed for the period of the reference for-instance one week foregoing the data of interview. The unemployment rate and output (GDP at constant local currency unit) data used in this study has been taken from Economic survey of Pakistan that is published by Ministry of Finance (Government of Pakistan) and from Hand book of statistics for the period 1964-2014 at annual frequency.

ESTIMATION AND RESULTS

For the preliminary analysis data is transformed into logarithmic form as it would shrink the variability in variance of the time series data. First, the stationarity of the variables has been observed through Augmented Dicky-fuller test at level series given in Table 1:

TABLE 1

Test of Non Stationarity

ADF test (Level)				
Variable	c,t	Lag	t-statistics	Conclusion
U_t	c,t	1	-2.053	I(1)
Y_t	c,t	1	-1.182	I(1)
ADF test (1st difference)				
ΔU_t	C	--	-5.290*	I(0)
ΔY_t	C	--	-4.099*	I(0)

*Indicate significance level at 1%, 5% and 10%. C and t are drift and trend terms.

At first difference the t-statistics of ADF are in favor of alternative hypothesis at one percent level of significance. Therefore, both variables are integrated of order one and contain unit root. As it is shown (table 1) both the variables are cointegrated of same order, now attaining the residuals, by regressing both the variables at level, if residuals are integrated of order zero such as $\hat{\varepsilon}_t \sim I(0)$ then there would be a long run relationship established or variables are called cointegrated [EG (1987)]. By applying ADF auxiliary regression on $\hat{\varepsilon}_t$ as:

$$\Delta\hat{\varepsilon}_t = -0.0182\hat{\varepsilon}_{t-1} \quad (9)$$

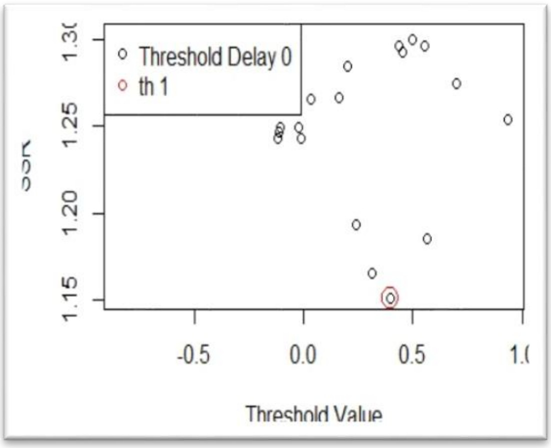
$$Auto\ {\chi^2}_{(1)} = 0.364 \quad Hetro\ {\chi^2}_{(1)} = 0.653$$

The t-statistics for $\hat{\varepsilon}_{t-1}$ coefficient is -0.45 and critical value at 5% level is -3.45, and accept the null hypothesis of unit-root at level and there does not exist symmetric adjustment for output and unemployment rate.

Whereas, nonlinear cointegration approach by Enders and Siklos (2001) is preferable. Now we include the asymmetric adjustment to test of stationarity of linear combination. It requires the threshold level of $\hat{\varepsilon}_t$ series, which is obtained by implemented Chang (1993) methodology for identifying unknown level of threshold below in Fig 3:

FIGURE 1

Threshold Level in Errors



After calculating the threshold value, the next step is to estimate the threshold cointegration model as proposed by Enders and Siklos (2001), the results of threshold cointegration is represented as:

$$\Delta\varepsilon_t = -1.1012 I_t \hat{\varepsilon}_{t-1} + 1.3025(1 - I_t)\hat{\varepsilon}_{t-1} \qquad (10)$$

$$Norm_{\chi^2_{(1)}} = 0.712 \quad Auto_{\chi^2_{(1)}} = 0.141 \quad Hetro_{\chi^2_{(1)}} = 0.443$$

Where $I_t = \begin{Bmatrix} 1 \; if \; \varepsilon_{t-1} \geq 0.3994 \\ 0 \; if \; \varepsilon_{t-1} < 0.3994 \end{Bmatrix}$

The significance of threshold cointegration against linear cointegration is tested under null hypothesis of linear cointegration against nonlinear cointegration i.e $H_0: \rho_1 = \rho_2$. F-calculated 13.63 which is higher than the F-critical (2,47) at 1% significance level is 5.06. It clearly rejects the null of linear cointegration against the nonlinear cointegration. It can be claimed that there is threshold cointegration and in long run there might be asymmetric adjustment between unemployment rate and output. Thus, there exists asymmetric adjustment, between output and unemployment rate whereas through traditional cointegration approach it was discarded.

Further, Hansen and Seo (2002) test also applied for the confirmation of existence of asymmetric adjustment in output and unemployment rate. The estimation and results are presented in Table 2 along the fixed regressor and residual bootstrap *p*-values as:

TABLE 2

Test of-Linear-Cointegration-Against-Threshold-Cointegration for Okun's law Difference model

			Sup *LM* $\hat{\beta}$ *estimated*
Test Statistic Value			15.1923
p-values: Fixed Regressor Bootstrap			0.0200
p-values: Residual Bootstrap			0.0100
Threshold parameter ($\hat{\gamma}$)			0.0536
Critical values (*Sup LM*):	90% (12.16)	95% (12.92)	99% (13.94)

Note: The $SupLM = \sup_{\gamma_L < \gamma \leq \gamma_U} LM^0(\beta_0, \gamma)$ is a LM heteroskedastic-consistent test statistics for null hypothesis of linear cointegration and alternative of threshold cointegration (i.e., there is no threshold effect against threshold effect), and $[\gamma_L, \gamma_U]$ is the search region set so that γ_L is the π_0 percentile of $\tilde{w}_{t-1}$, and γ_U is the $(1-\pi_0)$ percentile. p-values: 100 replications of bootstrap are reported.

Source: Hansen and Seo (2002)

Above in the Table 1, the *LM*-test statistics for threshold cointegration are significance at 1%, 5% and 10% level. The alternative of threshold cointegration is accepted against null of linear cointegration hypothesis. The estimated parameter of threshold for Hansen and Soe (2002) test of threshold cointegration in above Table 2 is as $\hat{\gamma} = 0.0536$. The graphical representation of linear versus threshold cointegration test and fixed regressor bootstrap value of the *LM*-statistics are presented in Figure 1 and density of bootstrap distribution of error correction term are in Figure 2 as:

FIGURE 2

Test of Linear Vs Threshold Cointegration

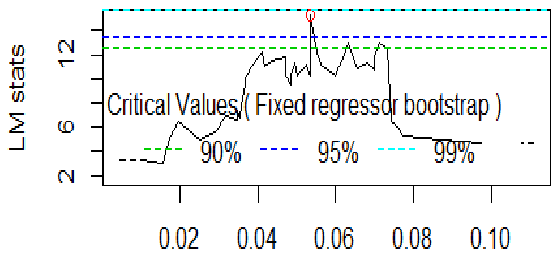
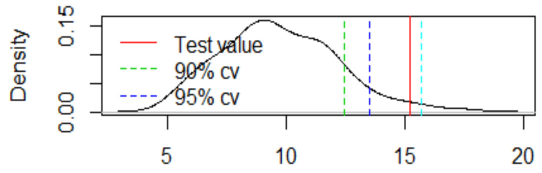


FIGURE 3

ECT Values (Density Bootstrap Distribution



The asymmetric adjustment in error correction term is calculated by estimating the threshold level in errors (Fig 3), then obtain the dummy variables as before threshold level or after threshold level in excel through '*if*' function and regressed the ordinary least square regression in software as before threshold level or after threshold level. The results are as follows:

$$\Delta u_t = 0.82\Delta y_{t-1} - 0.12 I_t ec_{t-1} + \sum_{i=1}^{2} \Delta u_{t-i} \quad if \quad ec_{t-1} > 0.3994 \qquad (11)$$

(0.43) (-1.25)

$$F_{(4,45)} = 5.05 \; Norm\,\chi^2{}_{(1)} = 0.32 \; Auto\,\chi^2{}_{(1)} = 0.27 \; Hetro\,\chi^2{}_{(2)} = 0.67$$

And

$$\Delta u_t = -3.29\Delta y_{t-1} - 0.38(1 - I_t)ec_{t-1} + \sum_{i=1}^{3} \Delta u_{t-i} \quad if \quad ec_{t-1} < 0.3994 \qquad (12)$$

(-1.81) (-2.72)

$$F_{(4,45)} = 2.20 \; Norm\,\chi^2{}_{(1)} = 0.32 \; Auto\,\chi^2{}_{(1)} = 0.73 \; Hetro\,\chi^2{}_{(2)} = 0.71$$

There are all statistical properties of the models are significant; for instance there is no problem of heteroscedasticity, autocorrelation and normality. Due to the autocorrelation problem two lags of dependent variables are included in (11) and three lags in (12). In parenthesis t-statistics are given. These error correction models in equation (11) and (12) producing different speed of adjustment parameters, as before threshold level and after threshold level. Here, there are two Okun's coefficient; such as weaker Okun's coefficient 0.82 (in eq. 11) has positive sign and insignificant too. On the other edge, the stronger Okun's coefficient is as -3.29 (i.e., Δy_{t-1}in eq (12)) that is almost too close to actual Okun's coefficient. It states that output decreases by 3.29% by one percent increase in unemployment rate. As before threshold level, the ECT_{t-1} is significant and showing that after threshold level the speed of adjustment towards long run equilibrium for output and unemployment rate are 38% (in eq (12)). But other side, after threshold level ECT_{t-1} is insignificant and showing there is no adjustment.

The parameter constancy is highly important for policy makers, in the study under consideration, to check the parameter constancy of the asymmetric adjustment model (11), the estimation of recursive least square has been used. Through this approach CUSUM as well as CUSUMQ statistics are directly constructed (Brown, et al., 1975). Likewise, the recursive coefficients estimate for asymmetric model (11), Okun's coefficient (Δy_{t-1}) and error correction term ($(1 - I_t)ec_{t-1}$) have been plotted below in Figures 4,5,6 and 7:

FIGURE 4

Plot of Cumulative Sum of Recursive Residual and 5% Significance Level Critical Bands

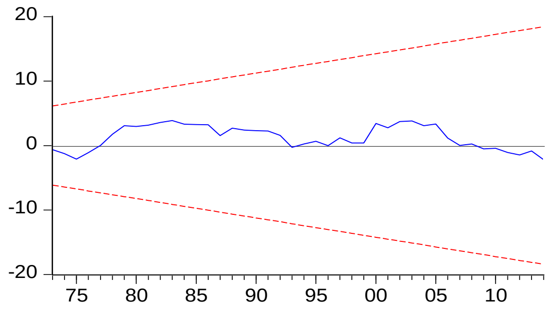


FIGURE 5

Plot of Cumulative Sum of Squares of Recursive Residual and 5% Significance Level Critical Bands

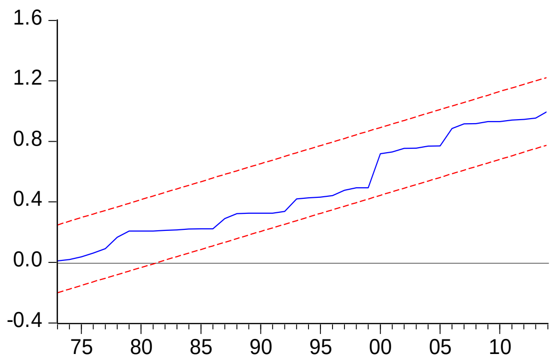


FIGURE 6

Okun's Coefficient and Its 2 Standard Error Bands

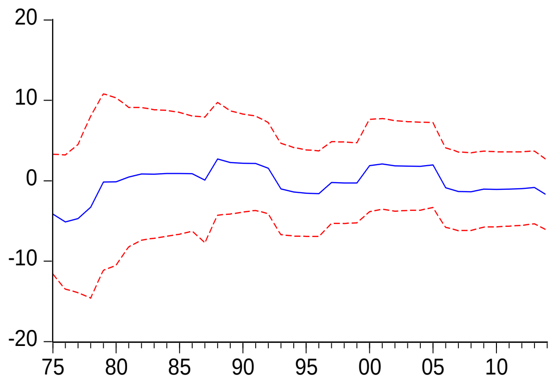
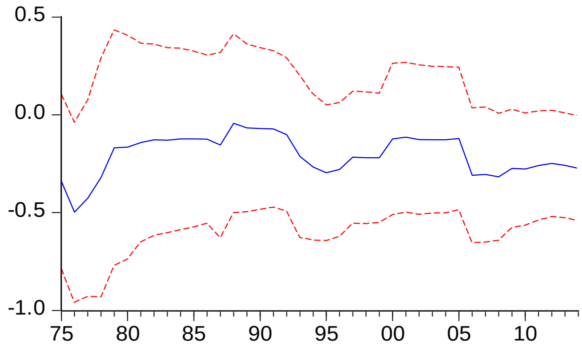


FIGURE 7

Coefficient ECT_{t-1} and its 2 Standard Error Bands



CONCLUSIONS

The foremost purpose of this research was to estimate the threshold cointegration along asymmetric adjustment in Okun's law that in case of Pakistan. ADF stationary test revealed that the unemployment rate and output is stationary at first order. Moreover, to estimate the Okun's relationship Engle and Granger (1987) methodology of linear cointegration had been implemented that rejected any long-run relationship. Next, threshold cointegration was brought forward, which showed that there is a stable long run relationship by means of threshold cointegration between unemployment rate and output. There are two error correction term depending upon the threshold value and gives different Okun's coefficient; as 0.82 (in eq. (11)) after threshold level that is insignificant and -3.29 (in eq. (12)) before threshold level that is significant and evidenced for the presence of Okun's law in case of Pakistan. Further, speed of adjustment coefficients; as -0.12 (in eq. (11)) after threshold level that is insignificant and shows that there is no stable relationship for Okun's law, and second one is as -0.38 (in eq. (12)) before threshold level that is significant and shows that there is a stable long run relationship for Okun's law in case of Pakistan. As, it can be analyzed that threshold level play a highly significant role, as after threshold level the Okun's coefficient is insignificant and asymmetric adjustment too. Although, before threshold level, almost Okun's coefficient is same as original value long run adjustment is quite rapid and both are significant. The policy maker should consider the threshold level while policy devising and try to push back unemployment rate before threshold level else both unemployment and output would grow simultaneously.

POLICY RECOMMENDATIONS

In this study, it is showed that when nonlinearity is identified in series then nonlinear model should be applied, as it produces better results. Based on the results of threshold cointegration and asymmetric adjustment in Okun's law the following policy implication are made:

i. There would be more information about the turning points of extensions and shrinkages for the participant of the market regarding the unemployment and output
ii. The policy maker should not support to promote new creation of job when output is high as equate to its usual level
iii. Either to reduce unemployment rate or increase the output the policy maker should increase or decrease corresponding determinants by analyzing the threshold regime of the series; that whether these are before or after threshold level so according to that increase or decrease corresponding determinants.

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